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Stunning, malnutrition and microelement deficiency in Vietnam. Part 2. (Literature review of research in Vietnam)

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ABSTRACT. The second review devoted to the analysis of malnutrition studies in Vietnam systematizes the existing ideas about the prevalence, causes and methods of correction of stunting, malnutrition, vitamin and micronutrient deficiencies and anemia over a period of almost thirty years. The analysis of the cited sources showed that in 2003–2024, the prevalence of stunting among Vietnamese children aged 5–19 years decreased from 40–60% to 14–25%. The prevalence of malnutrition over the same period among children of the same age group decreased from 11–25% to 6–9%. Anemia for 2001–2024 also decreased from an average of 20–45% to 9–20% in school-age children, 30–35% in younger children, in newborns from 84–90% to 12–20%, in women of reproductive age from 40 to 20–25%. Regardless of the observation period, up to 60% of women of reproductive age and younger children and 11–40% of schoolchildren and adult men suffer from vitamin D deficiency. The prevalence of vitamin A deficiency in 2005–2024 was 6–14% in school-age children and 15–20% in newborns and women of reproductive age. Deficiency of microelements (zinc, selenium, magnesium, calcium) is registered in 50–60% of schoolchildren. Vitamin B_{12} deficiency has been diagnosed in 3–15% of non-pregnant women and 8–12% of school-age children. The main factors of malnutrition, stunting, micronutrient and vitamin deficiencies are: anthropometric deficiency caused by malnutrition in parents, their low level of culture and education, inadequate breastfeeding, economic reasons for refusing to eat enough meat and vegetables, especially among residents of ethnic poor rural and mountainous regions, food shortages, as well as parasitic diseases and intestinal infections. Vitamin D deficiency is associated with traditional Vietnamese ideas about the physical attractiveness of a person with white skin.

Keywords: Vietnam, stunting, malnutrition, anemia, micronutrient deficiency

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Обзор

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Задержка роста, дефицит питания и микроэлементная недостаточность во Вьетнаме. Часть 2. (Литературный обзор исследований во Вьетнаме)

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РЕЗЮМЕ. Во втором обзоре, посвященном анализу исследований неполноценного питания во Вьетнаме, производится систематизация существующих в течение почти тридцатилетнего периода представлений о распространенности, причинах и методах коррекции задержки роста, недоедания, дефицита витаминов, микроэлементов и анемии. Анализ приведенных источников показал, что за 2003–2024 гг. у вьетнамских детей в возрасте 5–19 лет имеет место снижение распространенности низкорослости с 40–60% до 14–25%. Распространенность недоедания за этот же период у детей той же возрастной группы снизилась с 11–25% до 6–9%. Анемия за 2001–2024 гг. также уменьшилась со средних значений 20–45% до 9–20% у детей школьного возраста, 30–35% у младших детей, у новорожденных с 84–90% до 12–20%, у женщин репродуктивного возраста с 40 до 20–25%. Вне зависимости от периода наблюдения до 60% женщин репродуктивного возраста и младших детей и 11–40% школьников и взрослых мужчин страдают от дефицита витамина D. Распространенность дефицита витамина A за 2005–2024 гг. имелась у 6–14% детей школьного возраста и у 15–20% новорожденных и женщин репродуктивного возраста. Дефицит микроэлементов (цинка, селена, магния, кальция) зарегистрирован у 50–60% школьников. Недостаточность витамина B_{12} была диагностирована у 3–15% небеременных женщин и 8–12% детей школьного возраста. Основными факторами недоедания, низкорослости, дефицита микроэлементов и витаминов являются: антропометрический дефицит, вызванный недоеданием у родителей, низкий уровень их культуры и образования, неполноценное грудное вскармливание, экономические причины отказа от употребления достаточного количества мяса и овощей, особенно среди жителей этнических бедных сельских и горных регионов, дефицит продовольствия, а также паразитарные заболевания и кишечные инфекции. Недостаток витамина D связан с традиционными представлениями вьетнамцев о физической привлекательности человека с белой кожей.

Ключевые слова: Вьетнам, низкорослость, недоедание, анемия, дефицит микроэлементов

Источник финансирования. Авторы заявляют об отсутствии внешнего финансирования при проведении исследования.

INTRODUCTION

A previous review[1] reported that Vietnam, like many developing countries, is characterized by a double burden of malnutrition. This is a combination of high prevalence of undernutrition and obesity among people in the same area [1]. The main reasons for this situation in society are poverty in economically vulnerable regions and rapid urbanization in others, as well as changes in diet towards more calorie-dense, micronutrient-poor processed foods [2]. The second review discusses the prevalence and causes of stunting, underweight, and micronutrient deficiencies among the population of Vietnam, and presents the country's government strategy for preventing and treating these deficiencies.

AIM

The aim is to systematize existing knowledge accumulated over a period of almost thirty years regarding prevalence, causes, and methods of correction of stunting, malnutrition, vitamin and micronutrient deficiencies, and anemia in Vietnam.

ANALYSIS OF PREVALENCE AND CAUSES OF STUNTING IN VIETNAM

As shown in Table 1, from 1997 to 2003, more than 60% of children under the age of 10 were affected by stunting. Then, from 2005 to 2008, this figure decreased to an average of 38%. These data are consistent with those in the literature: L.M. Do et al. (2017) noted a decrease in the prevalence of stunting from 56.5% in 1990 to 30.7% in 2004. [3]. N.C. Khan et al. (2007), as a result of a repeat cross-sectional study from 1990 to 2005, also reported a significant decrease in the prevalence of stunting — from 45% in 1990 to 26.6% in 2004. [4]. In the following decade (2008–2017), there was a further decrease in the prevalence of stunting, which averaged 22% (ranging from 19% to 24%), with high values of this indicator observed among rural children. The results presented in Table 1 also correspond to published data: according to the Vietnam National Nutrition Survey conducted by the National Institute of Nutrition in 2010, stunting in children aged 5–19 years amounted to 23.4%, and in 2015, it was 25%.

The data on the prevalence of short stature from 2018 to 2024, presented in Table 1, show some inconsistency. Most studies report that the indicator analyzed during this period does not exceed 14% and averages 8%, which is consistent with the results of the 2019–2020 Vietnam National Nutrition Survey conducted by the National Institute of Nutrition in children aged 5–19 (14.8%) and the data of S.K. Wake et al. (10 to 15%) [5]. However, other authors have not been able to confirm a decrease in the prevalence of stunting after 2019. For example, D.V. Chuc et al. (2019) reported stunting in 24% of rural children [6]. J. Gausman et al. (2019) reported that this indicator occurs in 20–25% of children under the age of 15, and decreases to 12% only in adolescents [7]. These results contradict the studies by J.A. Robinson et al. (2023), who found a prevalence of growth retardation in 60% of one-year-olds and 12-year-olds [8], and X. Tan et al. (2024), who found short stature in 26% of children aged 16 to 18 years [9]. However, T. Beal et al. (2019), T.T. Le et al. (2019), P.Y. Tan et al. (2024), and C. Mondon et al. (2024) report a prevalence of stunting in children under 5 years of age ranging from 20% to 44%, especially in ethnically diverse groups [2, 10–12]. It should also be noted that currently (2023–2024), rural children lag behind urban children in growth by a factor of 2–3 (Table 1). According to D.L. Minh et al. (2018), the incidence of growth retardation increased among urban girls (from 23.1% in 2013 to 42.3% in 2016) and rural boys (from 11.4% in 2013 to 18.0% in 2016) [13]. All of these discrepancies are most likely due to the heterogeneity of the study sample.

According to Table 1, the prevalence of short stature in children under one year of age did not change over time and averaged 12–14% (ranging from 3% to 23%) over the entire observation period (2005 to 2024). Some Vietnamese researchers associate growth retardation at 6 months of age with high levels of late gestational ferritin, a marker of oxidative stress, risk of intrauterine infection, and impaired uteroplacental blood flow

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[1] This article is a continuation of the article “The double burden of malnutrition in developing countries as a global problem. Part 1. (Literature review of studies in Vietnam)”. (Russian Biomedical Research. 2025; 10(3):44–54. https://doi.org/10.56871/RBR.2025.80.56.005).

Table 1

Prevalence of stunting in Vietnam according to various authors

Таблица 1

Распространенность низкорослости во Вьетнаме по данным различных авторов

Автор Author	Контингент Contingent	Возраст Age	Распространенность Prevalence
Hop et al., 1997 [24]	14-летнее лонгитюдное наблюдение, 212 детей (1981–1994 гг.) 14-year longitudinal follow-up of 212 children (1981–1994)	0–10 лет 0–10 years	♂ — 59,4% ♀ — 58,3%
Thang et al., 2003 [45]	Смешанная выборка, 4367 детей[1] Mixed sample of 4367 children[1]	2–5 лет 2–5 years	58,8%
		6–11 лет 6–11 years	64,8%
Smuts et al., 2005 [46]	Смешанная выборка, 257 детей Mixed sample of 257 children	6–11 мес 6–11 months	8%
Watanabe et al., 2005 [47]	Смешанная выборка, 313 детей из провинции Тханьхоа Mixed sample of 313 children from Thanh Hoa province	6,5–8,5 лет 6.5–8.5 years	37,6%
Kulkarni et al., 2012 [48]	Смешанная выборка, 240 детей из сельской местности Mixed sample of 240 children from rural areas	5 мес — 2 года 5 months — 2 years	34,2%
Hien & Kam, 2008 [49]	Смешанная выборка, 650 детей из провинции Нгеан Mixed sample of 650 children from Nghe An province	0–5 лет 0–5 years	44,3%
Nhien et al., 2008 [25]	Смешанная выборка, 243 ребенка Mixed sample of 243 children	1–6 лет 1–6 years	36,2%
van Lierop et al., 2008 [50]	Смешанная выборка, 2613 детей из провинции Биньтхуан A mixed sample of 2613 children from Binh Thuan Province	6–10 лет 6–10 years	Городские — 17,3% City — 17.3% Сельские — 23,8% Rural — 23.8% Общая — 21,4% Total — 21.4%
Petrou & Kupek, 2010 [51]	Смешанная выборка, 2000 детей A mixed sample of 2000 children	6 мес — 1,5 года 6 month — 1.5 years	10–23,6%
Vaktskjold et al., 2010 [33]	237 детей из провинции Кханьхоа[2] Mixed sample 237 children from Khanh Hoa province[2]	Новорожденные Newborns	18%
Nakamori et al., 2010 [26]	Смешанная выборка, 188 детей из сельских районов Mixed sample of 188 children from rural areas	6 мес — 1,5 года 6 months — 1.5 years	23,4%
Le Nguyen et al., 2013 [52]	Смешанная выборка, 2872 ребенка Mixed sample of 2872 children	0,2–11,9 года 0.2–11.9 years	4% (<5 лет) (<5 years)
Ali et al., 2013 [53]	Смешанная выборка, 3075 детей Mixed sample of 3075 children	6 мес — 5 лет 6 months — 5 years	Легкая — 23,2% Mild — 23.2% Средняя — 27,8% Average — 27.8% Тяжелая — 25,6% Severe — 25.6%
Lundeen et al., 2014 [54]	Лонгитюдное исследование в течение от 1 до 8 лет Longitudinal study over 1 to 8 years	1 год 1 year	21%
		5 лет 5 years	24%
		8 лет 8 years	19,2%

Continuation of the Table 1 / Продолжение табл. 1

Автор Author	Контингент Contingent	Возраст Age	Распространенность Prevalence
Hanieh et al., 2015 [14]	Смешанная выборка, 1046 детей провинции Ханам Mixed sample of 1046 children from Hanam province	0–12 мес 0–12 months	6,4%
Dearden et al., 2017 [35]	Смешанная выборка, 1905 детей Mixed sample of 1905 children	1 год 1 year	19,7%
		5 лет 5 years	24,3%
		8 лет 8 years	19%
Georgiadis et al., 2017 [30]	Смешанная выборка, 2000 детей, лонгитюдное исследование Mixed sample of 2000 children longitudinal study	1 год 1 year	6%
		5 лет 5 years	4%
		8 лет 8 years	3%
Dat et al., 2018 [55]	Смешанная выборка, 6514 детей из провинции Биньдинь Mixed sample 6514 children from Binh Dinh province	6–10 лет 6–10 years	6,16%
Hoang et al., 2018 [56]	Смешанная выборка, 2334 детей из г. Хайфон Mixed sample of 2334 children from Hai Phong City	6–9 лет 6–9 years	5,1%,
Chuc et al., 2019 [6]	Смешанная выборка, 327 детей из Ким Донга, сельского округа провинции Хынгйен A mixed sample of 327 children from Kimdong, a rural district in Heungyeong Province	1–3 года 1–3 years	23,5%
Gausman et al., 2019 [7]	Смешанная выборка, 1833 ребенка Mixed sample of 1833 children	1 год 1 year	20,8%
		5 лет 5 years	25,4%
		8 лет 8 years	20,2%
		12 лет 12 years	19,4%
		15 лет 15 years	12,3%
Giao et al., 2019 [57]	Смешанная выборка, 768 детей из г. Хошимин Mixed sample of 768 children from Ho Chi Minh City	1–2 года 1–2 years	8,2%
Huynh et al., 2019 [22]	Смешанная выборка, 225 детей из больницы г. Хошимин Mixed sample of 225 children from Ho Chi Minh City Hospital.	6 мес — 5 лет 6 months — 5 years	22%
Beal et al., 2019 [10]	Смешанная выборка, 30 771 ребенок Mixed sample of 30,771 children	6 мес — 2 года 6 months — 2 years	17,5%
Beal et al., 2020 [58]	Смешанная выборка, 55 161 ребенок mixed sample of 55,161 children	2–5 лет 2–5 years	21,4%
Le et al., 2019 [11]	Смешанная выборка, 16 177 детей из горных районов, разные этнические группы Mixed sample of 16,177 children from mountainous areas, different ethnic groups	2–5 лет 1–5 years	29–43,9%
Mai et al., 2020 [1]	Смешанная выборка, 10 949 детей из г. Ханой Mixed sample of 10,949 children from Hanoi	6–18 лет 6–18 years	3,8%

Continuation of the Table 1 / Продолжение табл. 1

Автор Author	Контингент Contingent	Возраст Age	Распространенность Prevalence
Mai et al., 2020 [59]	Смешанная выборка, 10 949 детей 6–18 лет г. Хошимин Mixed sample of 10,949 children aged 6–18 Ho Chi Minh City	Младшие Juniors	2%
		Старшие Senior	8%
Quyen et al., 2020 [60]	240 детей до 2 лет округа Камкхе провинции Фу Тхо 240 children under 2 years old in Kam Khe district of Phu Tho province	6 мес 6 months	8,2%
		1 год 1 years	11,7%
		1,5 года 1.5 years	14,8%
		2 года 2 years	12,4%
Truong et al., 2022 [61]	Смешанная выборка, 1556 детей Mixed sample of 1556 children	средний возраст 12 лет average age 12 years	14,4%
Nguyen et al., 2023 [18]	340 детей из Национальной больницы акушерства и гинекологии г. Ханой 340 children from the National Hospital of Obstetrics and Gynecology in Hanoi	0–12 мес 0–12 months	14,1%
Robinson et al., 2023 [8]	Смешанная выборка, 1726 детей Mixed sample of 1726 children	1 год 1 years	58%
		8 лет 8 years	18,3%
		12 лет 12 years	56,8%
		15 лет 15 years	38,2%
Wake et al., 2023 [5]	Смешанная выборка, 9710 детей, лонгитюдное исследование Mixed sample of 9710 children, longitudinal study	В 2002 году In 2002	Умеренно — 15,1% Moderat — 15.1% Значительно — 5,7% Significant — 5.7%
		В 2006 году In 2006	Умеренно — 20,4% Moderat — 20.4% Значительно — 4,9% Significant — 4.9%
		В 2009 году In 2009	Умеренно — 16,9% Moderat — 16.9% Значительно — 3,2% Significant — 3.2%
		В 2013 году In 2013	Умеренно — 15,2% Moderat — 15.2% Значительно — 4,4% Significant — 4.4%
		В 2016 году In 2016	Умеренно — 10,2% Moderat — 10.2% Значительно — 2% Significant — 2%
Tan et al., 2024 [9]	Смешанная выборка, 2039 детей Mixed sample of 2039 children	6 мес — 2 года 6 months — 2 years	♂ —14% ♀ — 7,7% Общее 10,9% Total 10.9%

Ending of the Table 1 / Окончание табл. 1

Автор Author	Контингент Contingent	Возраст Age	Распространенность Prevalence
Mondon et al., 2024 [2]	Смешанная выборка (обзор) Mixed sample (review)	5 лет 5 years	22,4%
Thuy Tran et al., 2024 [34]	Смешанная выборка, 4001 ребенок в возрасте от 0,5 до 11,9 лет из разных регионов Mixed sample of 4001 children aged 0.5 to 11.9 years from different regions	0,5–0,9 года 0.5–0.9 years	Городские — 3% City — 3% Сельские — 10,2% Rural — 10.2%
		1,0–3,9 года 1.0–3.9 years	Городские — 8,2% City — 8.2% Сельские 14,5% Rural 14.5%
		4,0–6,9 года 4.0–6.9 years	Городские 1,8% City — 1.8% сельские 11,3% Rural — 11.3%
		7,0–11,9 года 7.0–11.9 years	Городские — 3,5% City — 3.5% Сельские — 12,1% Rural — 12.1%
Tan et al., 2024 [62]	1471 девочка[3] 1471 girls[3]	10–12 лет 10–12 years	12,4%
		13–15 лет 13–15 years	13,1%
		16–18 лет 16–18 years	26,8%
Tan, Chan et al., 2024 [12]	Смешанная выборка[4] Mixed sample[4]	<5 лет <5 years	19,6%
		5–18 лет 5–18 years	3,7%

Note: [1]ages 2–11 years in 1992–1993 as part of the Vietnam Living Standards Measurement Surveys; [2] born from one fetus between May and July 2005 in three main maternity hospitals; [3] in 10–18 year old female participants in the 2020 Vietnam Nationally Representative Survey on General Nutrition; [4] data on overall prevalence and prevalence stratified by sex and region were obtained from WHO/UNICEF/World Bank Group databases and national nutrition surveys (2018–2020) .

Примечание: [1] возраст от 2 до 11 лет в 1992–1993 гг. в рамках Исследования уровня жизни населения Вьетнама; [2] родившихся от одной матери в период с мая по июль 2005 года в трех основных родильных клиниках; [3] участницы общенационального репрезентативного исследования Вьетнама по общему питанию 2020 года в возрасте 10–18 лет; [4] данные об общей распространенности и распространенности, стратифицированной по полу и региону, были получены из баз данных ВОЗ/ЮНИСЕФ/Группы Всемирного банка и национальных обследований питания (2018–2020 гг.).

[14], as well as low levels of vitamin D [14]. According to other authors, the main cause of early onset of fetal and neonatal growth retardation is protein-energy malnutrition among pregnant women in rural areas of Vietnam [15], since other factors (heredity, environmental factors, etc.) can explain only 2–3% of intrauterine body length variation [16]. A mother's height of less than 145 cm and/or a body mass index (BMI) of <18.5 kg/m2 in early pregnancy is a generally accepted criterion for high risk of giving birth to a baby with low weight in relation to gestational age [17], which is typical for Vietnam [10, 18]. M.F. Young et al. (2018) found these extremely low physical development indicators in 30% of women in Vietnam [19]. T. Beal et al. (2019) reported that maternal height of 145–149 cm increases the risk of short stature in children by 49–62%, and less than 145 cm by 82% [10]. According to studies by M.F. Young et al. (2018) and P.H. Nguyen et al. (2021), short stature in children born to mothers with growth and weight deficits cannot be compensated for by the age of 2–7 years [19, 20].

Additional risk factors for low birth weight in Vietnam, according to the researchers, are maternal age over 35 years, serum albumin deficiency (an indicator of malnutrition), a history of anemia and premature birth [18], as well as birth weight <2500 g, maternal age <20 years, >2 children in the family [10, 21], child diarrhea, three or more children in the family [22], and heavy physical work during pregnancy [23]. Some studies have shown that the growth of Vietnamese infants began to lag behind the Western control population from the age of 4–5 months due to inadequate introduction of complementary foods [24, 25].

Traditional beliefs can influence breastfeeding practices. Currently, the prevalence of breastfeeding among children aged 0 to 6 months is no more than 20% [26]. Some Vietnamese mothers perceive colostrum as a "dirty" product with no nutritional value, which leads to lower rates of initiation of breastfeeding [27]. Families, especially older members (mothers-in-law and grandmothers), friends, and neighbors play a significant role in shaping mothers' beliefs and practices regarding breastfeeding in infancy and adolescent nutrition [27, 28]. Physical and emotional support from husbands and families, as well as mothers' education, increase mothers' knowledge, beliefs, and confidence in following optimal breastfeeding practices [28]. In addition, the marketing of infant formula can negatively affect feeding practices in the first year of life by distorting information about dangers of breastfeeding [29]. It is therefore important to consider social and cultural traditions in future research aimed at improving child nutrition, especially in the context of limited resources and cultural diversity in Vietnam.

It is well known that social and economic factors such as the level of education, ethnic diversity, poverty, living in economically disadvantaged rural areas, and lack of access to health care facilities increase the risk of stunted growth [10, 30]. For example, children of mothers with no education or only primary education were 77% more likely to experience stunted growth than their peers born to mothers with higher education [10]. According to R.E. Black et al. (2013), about 15% of Vietnamese mothers do not have a sufficient level of education, which highlights the need to improve access to education for women [17]. It has been shown that parents with sufficient education are more responsive to specialists' recommendations regarding breastfeeding practices [31]. The close relationship between low maternal height and stunted growth in children in Vietnam indicates the importance of nutritional correction before and during pregnancy [17].

Tan et al. (2024) found that the well-being index was higher among adolescents who did not suffer from stunting [12], which is consistent with previous studies that linked household well-being to the absence of stunting in children in developing countries, including Vietnam [32].

It has also been shown that the prevalence of short stature is higher among children from minority groups living in rural areas [10, 33, 34]. The risk of stunting among those surveyed living in the northeast of the country was twice as high as in the southeast, 72–83% higher than in the northwest, and 62–75% higher than in the central northern region and the Central Highlands [10]. This geographic pattern clearly reflects differences in social and economic status, the proportion of ethnic minorities, and access to food, health services, and clean water [35]. Such factors as small landholdings, the capacity of agricultural systems to provide sufficient food quality, and the level of government support pose a challenge to social and economic development in these regions [36]. Regional differences in risk factors for stunting suggest that regional policies should be adapted to address stunting, with priority given to ethnic minorities in the Central Highlands, as well as low birth weight children from low-educated families in the Southeast and mountain communities in the Northwest [10]. Living in a poor community was associated with an increased risk of stunting due to low social and economic status, both at the community level and at the level of individual households [37]. Studies show that children from ethnic minorities, poor families, predominantly rural and living in mountainous areas, do not have access to foods rich in nutrients such as meat, dairy products, eggs, fruits, and vegetables rich in vitamin A [12]. Social minority groups in Vietnam are much more likely to live in conditions of moderate or severe food insecurity and have less access to health services, improved sanitation, and water supplies available in urban areas [38]. For this reason, they have a higher prevalence of parasitic infections and diarrhea, leading to stunted growth in children under 5 years of age [39].

The US military launched a military campaign called "Operation Ranch Hand" during the Vietnam War to destroy the vegetation used by North Vietnamese troops for camouflage, during which herbicides were repeatedly sprayed in South Vietnam. It is estimated that between 1961 and 1971, ~77 million liters of herbicides, including 49.3 million liters of Agent Orange containing more than 360 kg of dioxin-contaminated defoliants, were sprayed several times over an area of

2.6 million acres [40]. In Vietnam, the number of people exposed or potentially exposed to Agent Orange was estimated at 4.8 million [40]. Studies from 1966 to 2002, summarized in reviews by J.E. Michalek et al. (1998) and A.D. Ngo et al. (2006), reported on the effects of Agent Orange and its dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin) used during the Vietnam War, on males and its relationship to short stature in their children [41, 42]. It is well known that organochlorine pesticides disrupt cell differentiation processes and endocrine regulation of growth and development [43], and their effects are transmitted across generations [44].

Thus, an analysis of growth retardation prevalence among children of all age groups over a period of more than 20 years showed a decrease in the percentage of short children in the Vietnamese population. Antenatal and infant growth retardation is usually the result of anthropometric deficiency in the mother caused by malnutrition and other factors related to her health, as well as her willingness to follow breastfeeding recommendations. Short stature in school-age and adolescent children is associated with social and economic factors: living in poor, rural mountainous areas and belonging to ethnic minorities.

ANALYSIS OF INCIDENCE AND CAUSES OF UNDERWEIGHT IN VIETNAM

The main trends in the incidence of underweight among children of different ages are shown in Table 2. The data show that until 2000, approximately 60–70% of school-age children were malnourished. Subsequently, the rate declined: from 2003 to 2013, malnutrition was recorded on average in 18% (from 11 to 25%) of children under the age of 12. However, the authors of two studies conducted in 2008 did not note a decrease in body mass deficiency during this period: N.N. Hien and S. Kam found malnutrition in 45–50% of younger children, while N. van Nhien et al. found it in older children (Table 2). From 2013 to 2017, there was a decrease in the percentage of malnourished children, and in 2018–2024, this indicator averaged 6% (3–9%) among children of this age. These facts are partially consistent with the literature data. A repeat cross-sectional study from 1992 to 2002 in children aged 2 to 17 years showed an increase in underweight from 32.1% to 33.5% [63].

There were differences between urban and rural children throughout the observation period. At the same time, according to studies conducted between 2008 and 2013, the prevalence of malnutrition among rural children was 6–15% higher than among their peers in large cities [13, 45, 50], while recent studies report that this difference is approximately 3–5% [1, 9, 34]. As noted, the causes of nutritional deficiencies, especially in rural areas, are: low economic status [2, 45, 49], insufficient access to food among rural residents [64, 65], inadequate diets in preschool institutions [66], a deficiency of macro- and micronutrients necessary for growth (protein, iron, zinc, vitamin D) [2, 9, 12], poor hygiene and contamination of drinking water sources [35], floods, droughts, or other natural disasters [2, 49], inadequate maternal nutrition [2], unsafe childbirth, and high infant morbidity rates [67]. It has been established that almost 60% of children aged 0.5–0.9 years and almost 90% of children aged 7–11.9 years did not follow the recommendations for energy, protein, calcium, iron, and vitamins A, C, and D intake [34]. The average measured total energy intake for Vietnamese residents was 2,196 kcal/day [28]. According to 2024 estimates, approximately 80% of children did not consume the amount of energy appropriate for their age [34]. Carbohydrates account for 65.6% of energy requirements, while fats and proteins account for 19.5% and 14.8%, respectively [28]. Approximately 55% of Vietnamese people have a low-fat diet, and the same percentage exceed the recommended level of carbohydrate consumption [28]. Only 5.2% of women of reproductive age achieved adequate consumption of n-3 and n-6 long-chain polyunsaturated fatty acids [28]. The main source of energy was rice and other starchy foods (62.6%), followed by meat and meat products (9.2%), and legumes/nuts/seeds and fruits (5% each). Animal products (meat, fish, eggs, and dairy products), excluding lard, accounted for 12.7% of total energy intake. Daily intake of protein, fat, and carbohydrates was 82 g, 49 g, and 356 g, respectively. Rice and other products were the main source of protein (30 g/day), followed by meat and meat products (17.7 g/day), as well as legumes, nuts, and seeds (7.9 g/day). The main sources of fat consumption in the diet were meat and meat products (14.0 g/day); oils, lard, and butter (8.6 g/day); and legumes, nuts, and seeds (6.1 g/day) [68]. Most of the

Table 2

Prevalence of malnutrition in Vietnam according to various authors

Таблица 2

Распространенность дефицита массы тела во Вьетнаме по данным различных авторов

Автор Author	Контингент Contingent	Возраст Age	Недостаток веса Underweight	Истощение Starvation
Giay & Khoi, 1994 [96]	Смешанная выборка взрослых Mixed sample of adults	26–40 лет 26–40 years	40%	
Thang et al., 2003 [45]	Смешанная выборка, 4367 детей 2–11 лет в 1992–1993 годах[1] Mixed sample of 4367 children aged 2–11 years in 1992–1993[1]	2–5 лет 2–5 years	57%	
		6–11 лет 6–11 years	71,4%	
Smuts et al., 2005 [46]	Смешанная выборка, 257 детей Mixed sample of 257 children	6–11 мес 6–11 month	12,7%	3%
Kulkarni et al., 2012 [48]	240 детей из сельской местности 240 children from rural areas	5 мес — 2 года 5 month — 2 years	15,8%	
Cuong et al., 2007 [97]	Смешанная выборка, 1488 взрослых из г. Хошимин Mixed sample of 1488 adults from Ho Chi Minh City	20–60 лет 20–60 years	20,4%	
Watanabe et al., 2005 [47]	Смешанная выборка, 313 детей из г. Тханьхоа Mixed sample of 313 children from Thanh Hoa city	6,5–8,5 лет 6.5–8.5 years	11,4%	
Tang et al., 2007 [98]	1504 подростка из г. Хошимин (равное количество ♂ и ♀) 1504 adolescents from Ho Chi Minh City (equal of ♂ and ♀)	Средний возраст 13,1 года Average age 13.1 years	13,1%	
Hien & Kam, 2008 [49]	Смешанная выборка, 650 детей из провинции Нгеан Mixed sample of 650 children from Nghe An province	0–5 лет 0–5 years	44,3%	11,9%
van Nhien et al., 2008 [25]	Смешанная выборка, 243 ребенка Mixed sample of 243 children	1–6 лет 1–6 years	50,2%	14,4%
van Lierop et al., 2008 [50]	Смешанная выборка, 2613 детей из провинции Биньтхуан Mixed sample of 2613 children from Binh Thuan province	6–10 лет 6–10 years	Городские — 16,7 % City — 16.7% Сельские — 22,6% Rural — 22.6% Общая — 20,4% Total — 20.4%	
Walls et al., 2009 [99]	Смешанная выборка, 4846 взрослых из г. Ханой Mixed sample of 4846 adults from Hanoi	25–74 года 25–74 years	13,3%	
Dieu et al., 2009 [100]	Повторное поперечное исследование 2002–2005 гг., 1162 ребенка Repeated cross-sectional study 2002–2005 1162 children	4–5 лет 4–5 years	7,5%	
Vaktskjold et al., 2010 [33]	237 детей из провинции Кханьхоа 237 children from Khanh Hoa province	Новорожденные Newborns	19,8%	
Dang et al., 2010 [101]	Исследование детей в возрасте 6–15 лет с 1992 по 2000 гг. в городских и сельских регионах с учетом их экономического положения[2] A study of children aged 6–15 years from 1992 to 2000 in urban and rural areas, taking into account their economic status[2]	Городские City	25,7%	
		Сельские Rural	34,8%	
		Бедные Poor	35,2%	
		Богатые Rich	23,5%	

Continuation of the Table 2 / Продолжение табл. 2

Автор Author	Контингент Contingent	Возраст Age	Недостаток веса Underweight	Истощение Starvation
Petrou & Kupek, 2010 [51]	Смешанная выборка, 2000 детей Mixed sample of 2000 children	6 мес — 1,5 года 6 month — 1.5 years	11,2–16,8%	7,6%
Nakamori et al., 2010 [26]	Смешанная выборка, 188 детей из сельских районов Mixed sample of 188 children from rural areas	6 мес — 1,5 года 6 month — 1.5 years	19,7%	5,3%
Nguyen, Eriksson et al., 2012 [102]	Смешанная выборка, 1495 детей из г. Ханой Mixed sample of 1495 children from Hanoi	Новорожденные Newborns	Городские ♂ — 2,3% City ♂ — 2.3% Сельские ♂ — 4,1% Rural ♂ — 4.1% Городские ♀– 4,2% City ♀– 4.2% Сельские ♀ — 4,9% Rural ♀ — 4.9%	
Ali et al., 2013 [53]	Смешанная выборка, 3075 детей Mixed sample of 3075 children	6 мес — 5 лет 6 month — 5 years	19,7%	5,7%
Ly et al., 2013 [103]	Смешанная выборка, 1713 взрослых жителей из г. Дананг[3] Mixed sample of 1713 adults from Da Nang City[3]	≥35 лет ≥35 years	12,4%	
Nguyen et al., 2013 [68]	4983 небеременные женщины г. Тхай Нгуен 4983 non-pregnant women in Thai Nguyen City		31,71%	
Le Nguyen et al., 2013 [52]	Смешанная выборка, 2872 ребенка 0,2–11,9 лет[4] Mixed sample of 2872 children aged 0.2–11.9 years[4]	< 5 лет < 5 years	8,6%	4,4%
		5–11,9 года 5–11.9 years	22,2%	
Dearden et al., 2017 [35]	Смешанная выборка, 1905 детей Mixed sample of 1905 children	1 год 1 year	3,8%	
		5 лет 5 year	3,9%	
		8 лет 8 year	11,7%	
Dat et al., 2018 [55]	Смешанная выборка, 6514 детей из провинции Биньдинь Mixed sample of 6514 children from Binh Dinh Province	6–10 лет 6–10 years	11,19%	10,79%
Hoang et al., 2018 [56]	Смешанная выборка, 2334 ребенка из г. Хайфон Mixed sample of 2334 children from Hai Phong City	6–9 лет 6–9 years	8%	5,3%
Minh et al., 2018 [13]	1955 детей в возрасте 5,5–6,5 года разного пола и возраста, городские и сельские 1955 children aged 5.5–6.5 years of different sexes and ages, urban and rural	В 2013 году In 2013	Общее — 9,2% Total — 9.2% Городские ♂ — 4,4% City ♂ — 4.4% Сельские ♂ — 17,5% Rural ♂ — 17.5% Городские ♀ — 3,4% City ♀ — 3.4% Сельские ♀ — 16,7% Rural ♀ — 16.7%	
		В 2014 году In 2014	Общее — 6,9% Total — 6.9% Городские ♂ — 12.3% City ♂ — 12.3% Сельские — 12,3% Rural ♂ — 12.3%	

Continuation of the Table 2 / Продолжение табл. 2

Автор Author	Контингент Contingent	Возраст Age	Недостаток веса Underweight	Истощение Starvation
			Городские ♀ — 2,5% City ♀ — 2.5% Сельские — 12,3% Rural ♀ — 12.3%	
		В 2016 году In 2016	Общее — 4,9% Total — 4.9% Городские ♂ — 3,0% City ♂ — 3.0% Сельские ♂ — 4,0% Rural ♂ — 4.0 % Городские ♀ — 3,6% City ♀ — 3.6% Сельские ♀ — 9,3% Rural ♀ — 9.3%	
Chuc et al., 2019 [6]	Смешанная выборка, 327 детей г. Хынъен Mixed sample of 327 children from Heungyeong City	1–3 года 1–3 year	7,6%	6,7%
Huynh et al., 2019 [22]	Смешанная выборка, 225 детей из больницы в г. Хошимин A mixed sample of 225 children from a hospital in Ho Chi Minh City	6 мес — 5 лет 6 month — 5 years	19%	10%
Pham et al., 2019 [104]	Смешанная выборка, 821 ребенок из г. Ханоя[5] Mixed sample of 821 children from Hanoi[5]	11–12 лет 11–12 years	4,1%	
Mai et al., 2020 [59]	Смешанная выборка, 10 949 детей 6–18 лет из г. Хошимин Mixed sample of 10,949 children aged 6–18 Ho Chi Minh City	Младшие (город) Junior (city)	2–9%	
		Старшие (город) Senior (city)	6–18%	
		Сельские Rural	4,6%	
Quyen et al., 2020 [60]	240 детей до 2 лет из округа Камкхе провинции Фу Тхо 240 children under 2 years old from Kam Khe district, Phu Tho province	Новорожденные Newborns	15,6%	
		6 мес 6 month	3,9%	3%
		1 год 1 year	3,9%	1,3%
		1,5 года 1.5 years	1,3%	1%
		2 года 2 years	7,3%	2,3%
Truong et al., 2022 [61]	Смешанная выборка, 1556 детей Mixed sample of 1556 children	Средний возраст 12 лет Average age 12 years	5,4%	
Nguyen et al., 2023 [18]	Смешанная выборка, 340 детей[6] Mixed sample of 340 children[6]	0–12 мес 0–12 month	12,4%	
Tan et al., 2024 [9]	1471 девочка 1471 girls	10–12 лет 10–12 years	9,4%	
		13–15 лет 13–15 years	5%	
		16–18 лет 16–18 years	2,7%	

Ending of the Table 2 / Окончание табл. 2

Автор Author	**Контингент** Contingent	**Возраст** Age	**Недостаток веса** Underweight	**Истощение** Starvation
Tan et al., 2024b [12]	Смешанная выборка, 2039 детей Mixed sample of 2039 children	6 мес — 2 лет 6 month — 2 years	♂ — 7,2% ♀ — 3,9% Общее — 5,6% Total — 5.6%	♂ — 3,6% ♀ — 3,2% Общее — 3,4% Total — 3.4%
Pham et al., 2024 [95]	108 мужчин и женщин из г. Хошимин[7] 108 men and women from Ho Chi Minh City[7]	Пожилой возраст Old age	72,2%	
Mondon et al., 2024 [2]	Смешанная выборка детей Mixed sample of children	<5 лет <5 years	12,2%	5,2%
Thuy Tran et al., 2024 [34]	Смешанная выборка, 4001 ребенок в возрасте от 0,5 до 11,9 лет Mixed sample of 4001 children aged 0.5 to 11.9 years	0,5–0,9 лет 0.5–0.9 years	Городские — 5,1% City — 5.1% Сельские — 5,1% Rural — 5.1%	
		1,0–3,9 лет 1.0–3.9 years	Городские — 3,2% City — 3.2% Сельские — 2,8% Rural — 2.8%	
		4,0–6,9 лет 4.0–6.9 years	Городские — 6,6% City — 6.6% Сельские — 2,5% Rural — 2.5%	
		7,0–11,9 лет 7.0–11.9 years	Городские — 2,2% City — 2.2% Сельские — 7,5% Rural — 7.5%	

Notes: [1]Vietnam Living Standards Measurement Surveys; [2] Vietnam Living Standard Survey (1992–1993), General Nutrition Survey (2000); [3] 900 households in 6 of 56 urban, rural and mixed urban-rural communities in Da Nang; [4]the South East Asian Nutrition Surveys (SEANUTS); [5] National Hospital of Obstetrics and Gynecology in Hanoi; [6] Vietnam Nationally Representative Nutrition Survey 2020 (girls 10–18 years); [7]hospital patients at the University Medical Center.

Примечания: [1] Исследование уровня жизни населения Вьетнама; [2] Исследование уровня жизни во Вьетнаме (1992–1993), Общее исследование состояния питания (2000); [3] 900 домохозяйств в 6 из 56 городских, сельских и смешанных городских-сельских общин в Дананге; [4] проект Обследования питания в Юго-Восточной Азии (SEANUTS); [5] Национальная больница акушерства и гинекологии в г. Ханой; [6] Общенациональное репрезентативное исследование Вьетнама по питанию 2020 г. (девочки 10–18 лет); [7] стационарные пациенты в Университетском медицинском центре.

protein requirement is met by low-calorie foods such as fish, crustaceans (shrimp, lobsters), mollusks (mussels), amphibians (frogs, snakes), and insects [69]. Data show a significant increase in the share of animal-based food consumption — from 12% in 1985 to 21% in 2010 [70]. Average per capita consumption of meat and poultry per day increased from 11 g in 1985 to 84 g in 2010. [70], oils and fats increased by 500% between 1985 and 2010, while vegetables decreased from 214 g per capita per day in 1985 to 190 g per capita per day in 2010 [70]. A large number of vegetables are a component of the diet mainly for residents of northern regions [71]. Children in Vietnam tend to have low consumption of nutrient-rich foods [72]. It was found that they consumed only 2.81 out of 7 groups of essential foods [72]. Only 39% of children consume dairy products [73], and they prefer ultra-pasteurized (84%) and flavored (34%) milk, which has less nutritional value than natural milk [74]. Fast food consumption is also on the rise [70, 75, 76], while meat consumption is declining [77]. It is reported that whole grains, lean meat, fish, low-fat dairy products, and fresh vegetables and fruits are consumed more by groups with high social and economic status, while refined grains and added fats are associated with lower living standards [78].

A cross-sectional study conducted from October 2018 to April 2019 in the Three Tons District, Anxiang Province, found a high prevalence of low (21.4%) and moderate (70.4%) dietary diversity scores [38]. Dietary diversity was higher in households headed by men with sufficient education and income, as well as those exposed to media promoting proper nutrition and health, with a high frequency of meals [38]. Low dietary diversity among Vietnamese people was directly correlated with sensory preferences regarding the appearance, smell, texture, and taste of food [79]. A monotonous diet is associated with slower linear growth in weight gain among Vietnamese children in their first two years of life [80].

Ethnic minorities living in mountainous areas are also at risk due to insufficient food supplies [2, 4, 45, 81] and a starchy, carbohydrate-rich diet [61, 82]. Truong et al. (2022) conducted studies in 2019–2020 and found that 14% of these children are underweight and 5.4% are severely malnourished [61]. A survey of children belonging to ethnic minorities found that 12.7–14% of participants regularly skipped breakfast and did not adhere to a healthy diet [61].

These regions experience food shortages for several months of the year between harvests [81], as well as seasonal fluctuations in the availability of protein and iron sources such as meat, fish, eggs, and seafood due to the inaccessibility of markets during the rainy season [83]. In addition, children in mountainous areas were less likely to consume foods such as fish, shrimp, crab, eel, snails, and mussels, as their mothers were simply unaware of the nutritional value and safe cooking methods for these seafood products [83].

Children from poor ethnic regions do not comply with hygiene requirements: washing their hands before eating and after using the toilet, undergoing deworming every 6 months [35, 61]. Poor sanitation is one of the main causes of high rates of stunted growth in mountainous areas [11, 84], as it can cause diarrhea and other digestive diseases [85]. Wastewater disposal measures [86] that improve sanitary conditions reduce the prevalence of diarrhea [87] and helminth infections [88] and decrease the prevalence of stunting [89].

Women from poor regions of Vietnam are more prone to mental illness, the prevalence of which is associated with stunted growth in their children [90].

A study by Upadhyay et al. (2021) reports a link between the use of solid fuels in economically disadvantaged households in Vietnam and the weight gain of children living there [91].

The prevalence of malnutrition among newborns and infants in their first year of life remained virtually unchanged during the observation period from 2005 to 2019, averaging 14% (ranging from 4% to 20%, Table 2). Only after 2020 did a downward trend to 4–7% emerge. Whether this decline is a pattern rather than a random statistical fact will be determined by further observations, since the 2024 study notes that the nutrition of 80.1% of children did not meet their calculated energy requirements [34].

Factors associated with malnutrition, as well as growth deficiency, in newborns may include: the level of education of mothers [28, 34, 56], refusal to breastfeed [12, 26] and its insufficient quality [92], infectious diseases [12, 26], low birth weight [26], large families [93] father's insufficient involvement in family life [94], and single-parent families [12].

Based on the assessment of 13 indicators of optimal feeding practices for newborns and infants in their first year of life recommended by WHO/UNICEF, only 36.7% of children achieved the minimum dietary diversity, and only 29% achieved the minimally acceptable diet [62].

The highest percentage of malnutrition among the adult population was recorded in 1994 (40%) and in 2024 when observing individuals with pathologies. From 2006 to 2013, this indicator remained virtually unchanged, hovering between 13% and 20% (see Table 2). Thus, malnutrition is common among elderly patients and can lead to prolonged treatment, disability, and increased mortality among elderly residents of the country [84, 95]. Vietnam is one of the countries with a rapidly aging population. According to the 2019 statistical forecast, the number of elderly people is 11.41 million (11.86% of the total population), and it will double by 2038 [95].

Thus, more than 30 years of experience in monitoring the quantitative characteristics of malnutrition in Vietnam shows an approximately 5-fold decrease in malnourished school-age children. At the same time, the prevalence of underweight adults and newborns has remained virtually unchanged since 2008. The main causes of underweight are: traditionally high carbohydrate intake, low levels of education, lack of knowledge about healthy eating, increased consumption of fast food, poverty, especially in ethnic mountain areas, limited food security, environmental pollution, intestinal infections, and parasitic diseases.

ANALYSIS OF VITAMIN AND MICRONUTRIENT DEFICIENCY PREVALENCE AND ITS CAUSES IN VIETNAM

Table 3 shows that the prevalence of anemia among school-age children in 2001–2008 ranged from 20% to

Table 3

Prevalence of anemia, deficiency of trace elements and vitamins in Vietnam according to various authors

Таблица 3

Распространенность анемии, дефицита микроэлементов и витаминов во Вьетнаме по данным различных авторов

Автор Author	Контингент Contingent	Возраст Age	Анемия Anemia	Дефициты Deficits			
				Железо Iron	Витамин A Vitamin A	Витамин D Vitamin D	Микроэлементы Microelements
Hershman et al., 1983 [127]	161 взрослый из разных районов 161 adults from different areas	23–26 лет 23–26 years	–	–	–	–	Дефицит йода Iodine deficiency — 28–45%
Hall et al., 2001 [105]	588 детей[1] 588 children[1]	7–11 лет 7–11 years	13%	–	–	–	–
Ta & Nguyen et al., 2003 [128]	284 девочки 284 girls	7–9 лет 7–9 years	–	–	7,1%	–	–
Smuts et al., 2005 [46]	257 детей 257 children	6–11 мес 6–11 month	89,9%	–	20,2%	–	Дефицит цинка — 22,5% Zinc deficiency — 22.5%
Hop & Berger, 2005 [129]	55 детей из г. Ханой 55 children from Hanoi	6 мес — 1 год 6 month — 1 year	84,9%		15,9%		Дефицит цинка — 22,5% Zinc deficiency — 22.5%
Aikawa et al., 2006 [130]	439 беременных женщин из провинции Нгеан 439 pregnant women from Nghe An province	–	43,2%	–	–	–	–
Nhien et al., 2008 [25]	243 ребенка из сельской местности 243 children from rural areas	1–6 лет 1–6 year	55,6%	–	11,3%	–	Дефицит цинка — 86,9% Zinc deficiency — 86.9% Дефицит селена — 62,3% Selenium deficiency — 62.3% Дефицит магния — 51,9% Magnesium deficiency — 51.9% Дефицит меди — 1,7% Copper deficiency — 1.7%
Khan et al., 2008 [131]	Сводная статистика у детей в возрасте до 5 лет Summary statistics for children under 5 years of age	–	20–40%	–	–	–	–
Pasricha et al., 2008 [117]	51 623 женщины, проживающие в округах Тран Йен и Йен Бинь 51,623 women living in Tran Yen and Yen Binh districts	–	37,53%	23,10%	–	–	–

Nhien N.V. et al., 2008 [25]	292 учащихся начальной школы из сельских районов 292 primary school students from rural areas	–	45%	11,3%	–	–	Дефицит цинка — 91,4% Zinc deficiency — 91.4% Дефицит селена — 75,6% Selenium deficiency — 75.6% Дефицит магния — 59,5% Magnesium deficiency — 59.5% Дефицит меди — 4,1% Copper deficiency — 4.1%
Van Nhien et al., 2009 [132]	245 девочек 245 girls	11–17 лет 11–17 years	20,4%	–	–	–	Дефицит цинка — 26,5% Zinc deficiency — 26.5% Дефицит селена — 15,9% Selenium deficiency — 15.9% Дефицит меди — 4,1% Copper deficiency — 4.1%
Vu et al., 2009 [133]	Небеременные женщины из г. Ханой Non-pregnant women from Hanoi	15–49 лет 15–49 years	19%	–	–	–	–
Casey et al., 2010 [108]	389 небеременных женщин из северных регионов 389 non-pregnant women from northern regions	Средний возраст 30 лет Average age 30 years	38%	19%	–	–	–
Phu et al., 2010 [112]		5 мес 5 month	40,8%	10,8%	–	–	–
Ho-Pham et al., 2011 [134]	205 мужчин и 432 женщины из г. Хошимин 205 men and 432 women from Ho Chi Minh City	18–87 лет 18–87 years	–	–	–	♂ — 20% ♀ — 46%	–
Fisher et al., 2011 [135]	413 беременных женщин провинции Ханам 413 pregnant women in Hanam province	–	–	–	–	–	Дефицит йода — 83% Iodine deficiency — 83%
Nguyen et al., 2012b [124]	269 женщин и 222 мужчины 269 women and 222 men	13–83 года 13–83 years	–	–	–	♂ — 16% ♀ — 20%	–
Hien et al., 2012 [136]	Беременные и небеременные женщины г. Ханой Pregnant and non-pregnant women from Hanoi	15–49 лет 15–49 years	–	–	–	48%	–

Continuation of the Table 3 / Продолжение табл. 3

Автор Author	**Контингент** Contingent	**Возраст** Age	**Анемия** Anemia	**Дефициты** Deficits			
				Железо Iron	**Витамин A** Vitamin A	**Витамин D** Vitamin D	**Микроэлементы** Microelements
Laillou et al., 2012a [125]	694 женщины 694 women	Репродуктивный возраст Reproductive age	–	38,4%	61,1%	–	Дефицит цинка — 91,8% Zinc deficiency — 91.8%
Laillou et al., 2013 [126]	532 ребенка 532 children	0–5 лет 0–5 years	–	–	–	21%	Дефицит кальция — 97% Calcium deficiency — 97%
Laillou et al., 2012b [137]	586 детей 586 children	6 мес — 6 лет 6 month–6 years	9,1%	12,9%	47,3%	–	Дефицит цинка — 51,9% Zinc deficiency — 51.9%
Laillou et al., 2014 [114]	1526 женщин 1526 women	Небеременные, репродуктивный возраст Non-pregnant, reproductive age	11%	13,7%	13,6%	–	Дефицит цинка — 67,2% Zinc deficiency — 67.2%
Le Nguyen et al., 2013 [52]	2872 ребенка 2872 children	0,2–11,9 года 0.2–11.9 years	38,65%	–	–	–	–
Le Nguyen et al., 2013 [52]	2872 ребенка 0.2–11.9 года (SEANUTS) 2872 children aged 0.2–11.9 years (SEANUTS)	2–4,9 года 2–4,9 years	18,25%	–	–	–	–
		5–11 лет 5–11 years	12,47%	–	7,75%	–	–
Siridamrongvattana et al., 2013 [107]	399 беременных женщин со сроком беременности <12 недель из Туа Тьен Хюэ 399 pregnant women <12 weeks of pregnancy from Thua Thien Hue	–	19,3%	–	–	–	–
Nguyen et al., 2013 [68]	254 беременные женщины из г. Хошимин 254 pregnant women from Ho Chi Minh City	–	–	–	–	–	Дефицит цинка — 25% Zinc deficiency — 25%
Tran et al., 2014 [138]	Беременные женщины на сроке от 12 до 20 недель Pregnant women from 12 to 20 weeks		Ранние сроки — 21,5% Поздние сроки — 24,4%	Ранние сроки — 4,1% Поздние сроки — 48,2%			

		–	Early pregnancy — 21.5% Late pregnancy — 24.4%	Early pregnancy — 4.1% Late pregnancy — 48.2%	–	–	–
Nguyen et al., 2014 [90]	4983 сельские женщины репродуктивного возраста 4983 rural women of reproductive age	–	–	24,8%	27,1%	63,8%	Дефицит цинка Zinc deficiency — 15.6%
Laillou A et al., 2014 [114]	1530 женщин репродуктивного возраста 1530 women of reproductive age	–	–	11,4%	При недостатке веса — 19% При ожирении — 7% Underweight — 19% / Obesity — 7%	–	Дефицит цинка — 61,1% Zinc deficiency — 61.1%
Poh et al., 2016 [139]	2016 детей 2016 children	2–15 лет 2–15 years	–	–	–	11,1%	–
Poh et al., 2016 [139]	SEANUTS, 2010/2011	–	–	–	–	Городские City ♂ — 9,3% ♀ — 14,7% Сельские Rural ♂ — 11,5% ♀ — 10,1%	–
Tuyen le D. et al., 2016 [121]	–	–	–	–	–	<5 лет — 58% <5 years — 58% 6–11 лет — 48,1% 6–11 years — 48.1%	–
Le Nguyen Bao et al., 2016 [109]	385 детей 385 children	6–11 лет 6–11 years	11,4%	5,6%	–	–	–
Nguyen et al., 2016 [15]	5011 беременных женщин 5011 pregnant women	–	1-й триместр — 18% 1st trimester — 18% 2-й триместр — 38% 2st trimester — 38% 3-й триместр — 34% 3st trimester — 34% Послеродовый 3-й мес — 38% Postpartum 3 months — 38%	13%	–	–	–

Ending of the Table 3 / Окончание табл. 3

Автор Author	Контингент Contingent	Возраст Age	Анемия Anemia	Дефициты Deficits			
				Железо Iron	Витамин А Vitamin A	Витамин D Vitamin D	Микроэлементы Microelements
			Послеродовая у детей — 42% Postpartum in children — 42%				
Chuc et al., 2019 [6]	327 детей г. Хынъен 327 children of Hung Yen city	1–3 года 1–3 years	33,3%	–	–	47,7%	–
Roos et al., 2019 [120]	Данные проекта SMILING[2] SMILING project data[2]	Разный возраст Different ages	17%	49%,	14,2%	–	–
Huynh et al., 2019 [22]	225 детей из больницы г. Хошимин 225 children from Ho Chi Minh City hospital	6 мес — 5 лет 6 months — 5 years	30,7%	–	–	–	–
Dat et al., 2019 [140]	1800 детей из провинции Биньдинь 1800 children from Binh Dinh province	8–10 лет 8–10 years	–	–	–	–	Дефицит йода Iodine deficiency Общее — 6,6% Total — 6.6% Городские — 5% City — 5% Сельские — 8% Rural — 8%
Hoang et al., 2019 [115]	893 ребенка сельских районов г. Хайфон 893 children in rural areas of Hai Phong	6–9 лет 6–9 years	Общая — 12,9% Total — 12.9% Микроцитарная — 7,9% Microcytic — 7.9% Нормоцитарная — 5,3% Normocytic — 5.3% Макроцитарная — 0% Macrocytic — 0%	–	–	–	–
Национальное исследование питания Вьетнама 2019–2020 гг. Vietnam National Nutrition Survey 2019–2020	Женщины Women	Трудоспособный возраст Working age	23,3%	–	–	–	Дефицит цинка — 42,6% Zinc deficiency — 42.6% Гиперкальциемия — 10,9% Hypercalcemia — 10.9%

Nguyen et al., 2021 [20]	Небеременные женщины Non-pregnant women	18–49 лет 18–49 years	–	–	–	–	Дефицит цинка — 85% Zinc deficiency — 85% Тяжелый дефицит цинка — 37% Severe zinc deficiency — 37%
Le Tuyen et al, 2022 [110]	Небеременные женщины Non-pregnant women	15–49 лет 15–49 years	25,5%	23,3%	–	–	–
Oktaria et al., 2022 [122]	Систематический обзор Systematic review	0–18 лет 0–18 years	–	–	–	0,9–96,4%	–
Tan & Chan et al., 2024 [12]	Обзор[3] Review[3]	<5 лет <5 years	35%	20%	6%	39%	–
		5–18 лет 5–18 years	20%	13%	6%	40%	
Tan et al., 2024b [9]	2039 детей 2039 children	6 мес — 2 года 6 month — 2 yeasr	♂ — 32,4% ♀ — 29,9%	♂ — 40% ♀ — 28,8%	14,3%	–	Дефицит цинка — 56,7% Zinc deficiency — 56.7%
Thuy Tran et al., 2024 [34]	4001 ребенок из разных регионов 4001 children from different regions	0,5–11,9 года 0,5–11.9 years	12%	–	6,2%	31,1%	Дефицит цинка — 60% Zinc deficiency — 60%

Note: [1]here and below, a mixed sample is assumed unless otherwise stated; [2]sustainable Micronutrient Interventions to Control Deficiencies and Improve Nutritional Status and General Health in Asia; [3]overall prevalence data and prevalence stratified by sex and region were obtained from WHO/UNICEF/World Bank Group databases and national nutrition surveys (2018–2020).

Примечание: [1]здесь и далее подразумевается смешанная выборка, если не указано другое; [2]устойчивые вмешательства в микроэлементы для контроля дефицита и улучшения состояния питания и общего состояния здоровья в Азии; [3]данные об общей распространенности и распространенности, стратифицированной по полу и региону, были получены из баз данных ВОЗ/ЮНИСЕФ/Группы Всемирного банка и национальных обследований питания (2018–2020 гг.).

45%. However, a single study conducted in 2001 failed to confirm these data [105]. Since 2010, there has been a decline in the number of anemic children, and in 2013–2024, this indicator averaged 13% (ranging from 9% to 20%). Anemia in younger children (aged 1 to 5 years) is an exception: according to some authors, its prevalence in 2019–2024 amounted to 30–35% [6, 12].

According to the data presented in Table 3, the prevalence of anemia in newborns also decreased from 84–90% in 2001–2005 to 38–40% in 2005–2019 and 12–20% in 2019–2024.

There was also a decrease in the number of anemic women of reproductive age and pregnant women (Table 3). While before 2013 this pathology was registered in more than 40% of those examined, in 2013–2022 anemia was diagnosed in 20–25% of women (according to some data, up to 35%).

These data are partially consistent with those found in the literature. A national study of nutritional risk factors in 1995 reported a high prevalence of anemia. Approximately 40–50% of young children and women were affected, but this figure fell after 2000 to 34% and 25%, respectively [106]. At the same time, iron deficiency anemia (IDA) was diagnosed in only 6%, while thalassemia accounted for 7.3% with a genetic predisposition of 26% of those examined, and 42.9% suffered from anemia for unknown reasons [107]. Adolescence is positively associated with anemia prevalence [9]. The low prevalence of IDA is confirmed by other authors. According to Casey et al. (2010), it occurs in 14% of non-pregnant women, Nguyen & Young et al. (2016) found it in 1.5% of pregnant women, and Le Nguyen Bao K. et al. (2016) observed it in 0.4% of children aged 6 to 11 years [20, 108, 109]. However, these data are inconsistent with the results of the 2010 National Nutrition Survey and the 2020 General Nutrition Survey in Vietnam. [110], which showed that about 37% of pregnant women suffer from IDA [111]. These results were reproduced by Phu et al. (2010), who showed that the prevalence of IDA remains quite high in children in their first year of life, at 21.7% [112].

At the same time, the prevalence of iron deficiency did not undergo significant fluctuations and corresponded to 11–13% (in some cases up to 40–50%) in school-age children, 10–12% in newborns, and 20–25% (in late stages 38–40%) in pregnant women and women of reproductive age.

The main causes of micronutrient and vitamin deficiencies are: the traditional preference of Vietnamese people for carbohydrate-starchy foods [28, 61, 82], modern trends towards an increase in the proportion of fast food in their diet [75, 76], and low consumption of fruits, vegetables, and meat due to their financial inaccessibility to residents of poor regions [38, 77]. According to studies by Bhutta et al. (2013), Hoang et al. (2019), Tan et al. (2024), poor nutritional status during pregnancy and in the neonatal period, maternal anemia, childhood stunting, and intestinal parasitic infections (giardiasis or ascariasis) were significant predictors of anemia in school-age children, while adequate consumption of iron-rich foods (meat, fruits, and vegetables) was a protective factor [9, 12]. Special studies have revealed low iron concentrations in the milk of women in Vietnam [113]. However, deficiencies in hemoglobin, ferritin, zinc, and vitamin A were not diagnosed in overweight individuals [114, 115]. Some studies have reported that iron deficiency is associated with malaria in ethnic minorities [116]. Anemia caused by parasites, especially hookworms, is a consequence of chronic blood loss [107]. Hookworm infection was the strongest factor associated with anemia, accounting for 22% of anemia cases [15]. Hookworm infections were significantly associated with hemoglobin levels [15]. In other studies, hookworm infection was not associated with anemia [117]. The most common parasites in Vietnam are *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), and hookworms (*Necator americanus* and *Ancylostoma duodenale*) [118]. Based on data from the Department of Parasitology and Malaria Control, Thua Thien Hue Health Service, the incidence of hookworm and malaria infection is quite low, with an average prevalence of 6.4% and <0.1%, respectively.

In 1985–1988, there was a high prevalence of clinical complications of vitamin A deficiency. Clinical assessment of vitamin A deficiency and xerophthalmia in more than 30,000 young children showed the presence of nyctalopia in 0.37% (WHO criterion no more than 1%), Bitot's spots in 0.16% (WHO criterion no more than 0.5%), corneal ulcers and keratomalacia in 0.07% (WHO criterion: no more than 0.01%), and corneal scarring in 0.12% (WHO criterion: no more than 0.05%) [119]. The prevalence of vitamin A deficiency remained relatively stable during the 2005–2024 observation period (Table 3): it was lowest among school-age children, ranging from 6 to 14% . Newborns and women of reproductive age accounted for 15–20% (in some cases up to 50% or more). At the same time, it is reported that vitamin A deficiency among children <5 years of age living in the Central Highlands and Northern Mountainous Regions is significantly higher than in other regions of the country (19–20%) [4, 120]. In the Red River Delta region, dark green leafy vegetables (average consumption 162 g/person per day) are the main source of plant carotenoids, while fruit consumption is quite low (52 g/person per day) [4].

The main risk factors for low serum retinol levels are a diet low in vitamin A sources (eggs, fruits, and vegetables), poor nutrition, and high levels of infections, particularly measles and diarrheal diseases [52], which are typical of low-income households [4].

Table 3 shows that, regardless of the observation period in Vietnam, up to 60% of women of reproductive age and young children (in some cases up to 90%) and 11–40% of schoolchildren and adult men suffer from vitamin D deficiency. Tuyen le D et al. (2016) found that the prevalence of vitamin D deficiency in adults increased from 7% (19% in pregnant women) in 2009 to 30% in 2012 and to 57% (36% in pregnant women) in 2013 among women living in Northern Vietnam. Deficiency of vitamin D varies greatly among different ethnic groups, they ranged from 0.9% to 96.4% in studies of Oktaria et al. (2022) and up to 58% in studies conducted by Stevens et al. (2022). Meanwhile, according to the authors [121], vitamin D deficiency is approximately twice less common in men than in women, which is consistent with the data presented in Table 3. Vitamin D deficiency increased from 22.8% in 2012 to 61.3% in 2015 among children under 6 months of age and from 66.7% in 2012 to 70.5% in 2014. among children aged 6 to 11 years in northern regions [121]. The SEANUTSII[1] (2021) [62] study showed a decrease in vitamin D deficiency compared to SEANUTS I (2011) [52]: 41.3% versus 52.7% for urban children and 23.3% versus 48.1% for rural children, respectively. The percentage of children suffering from vitamin D deficiency was higher in rural areas than in urban areas [71, 121]. Despite sufficient insolation (more than 100 sunny days per year[2]), vitamin D deficiency is a public health problem in Vietnam [122]. This phenomenon is explained by cultural traditions. Vietnamese people prefer wear closed clothing, use sun umbrellas, and have low outdoor activity, which limits their exposure to the sun [122], combined with low consumption of foods containing this vitamin, especially in children aged 6 months to 2 years [123]. Following rapid economic growth and increased cultural influence from Western countries, white skin has become part of the modern "concept of beauty," which is particularly attractive to the younger generation of women [124]. In addition, the effectiveness of sun exposure may be reduced by air pollution, haze, and altitude [124]. It should be noted that significant predictors of vitamin D deficiency in women were urban residence and age under 30. The winter season was a significant predictor in men [124].

The analysis of micronutrient deficiencies is also presented in Table 3. Zinc deficiency varied depending on the gender, age, and place of residence. The highest values were found among rural children, pregnant women, and women of reproductive age (75–90%). Zinc deficiency among infants and older children did not exceed 60%. Selenium, magnesium, and calcium deficiency in all Vietnamese residents, regardless of sample type, ranged from 50 to 60%. Zinc and selenium deficiency was positively associated with stunted growth and malnutrition in school-age children and adolescents [9, 115, 125].

Vitamin B_{12} deficiency was diagnosed in 3–15% of non-pregnant women [114, 126] and 8–12% of school-age children, regardless of gender and place of residence [125], due to insufficient consumption of meat and eggs [90]. However, there are no studies in Vietnam reporting the prevalence of macrocytic anemia [115].

A number of publications on iodine deficiency in Vietnam are limited. A 1983 study reported that iodine deficiency was found in 28–45% of adults, a 2011 study found it in 83% of pregnant women and women of reproductive age, and a 2019 study found it in 5–8% of schoolchildren (Table 3).

Therefore, 20 years of observations on anemia show a two- to threefold decrease in its prevalence among school-age children, pregnant women, and women of reproductive age. It is noteworthy that iron deficiency is not the leading cause of anemia among the Vietnamese population. Researchers attribute it to general protein-energy malnutrition and the spread of intestinal bleeding due to helminthic infestations. They

[1] Southeast Asian Nutrition Surveys

[2] https://www.statista.com/statistics/1089265/vietnam-annual-sunshine-duration-in-by-city/

also highlight nutritional causes in the spread of vitamin A and D deficiency due to the low consumption of eggs, meat, vegetables, and fruits among residents of poor rural areas. In addition, the cultural traditions of the Vietnamese people involve wearing closed clothing, which interferes with vitamin D synthesis in the skin. Subclinical deficiency of vitamin B_{12}, zinc, selenium, copper, and iodine should also be noted as a public health problem affecting the population.

KEY APPROACHES FOR PREVENTING AND TREATING DEFICIENCY DISEASES IN VIETNAM

Since the 1990s, starting with the First International Conference on Nutrition in 1992, Southeast Asian countries have adopted national nutrition strategies and action plans in order to eliminate the double burden of malnutrition (Food and Agriculture Organization of the United Nations),1992; World Health Organization (2018a)). The WHO conducted Global Nutrition Policy Reviews in 2009–2010 and 2016–2017 (World Health Organization (2013), World Health Organization (2018a)). The Report on Food Security in ASEAN (Association of Southeast Asian Nations) prepared by European Union, UNICEF & World Health Organization in 2016, presented nutrition-related issues covered by national strategies in Southeast Asian countries. The national nutrition strategy sets out goals for improving nutrition and measures aimed at supporting vulnerable groups such as women and children belonging to ethnic minorities and living in poor areas [141], and implements a set of measures to reduce poverty, provide financial support to the population, provide credit, develop agriculture, and improve health care [2, 142]. Improving the nutritional status and diet of children has been a priority for the Vietnamese government since 2000. (National Nutrition Strategy for 2001–2010) [143]. Rapid economic development has helped to improve the nutritional status of the population, along with specific nutrition efforts by the Vietnamese government [141].

The National Nutrition Strategy for 2011–2020 with a vision for 2030[1] is a multi-sectoral policy document aimed at improving the quantity and quality of the Vietnamese diet, reducing child undernutrition, and managing obesity and overweight. The vision for 2030 is to reduce child malnutrition below the level of public health significance and to increase the average height of adults. In addition, awareness of proper nutrition and behavioral change should be promoted among the general population to prevent nutrition-related chronic diseases, and food safety should be ensured.

The main objective of the current National Nutrition Strategy (Decision No. 02/QD-TTg 2022) for 2021–2030 and the Vision for the period up to 2045 is[2]: to promote proper nutrition for improving the nutritional status of each individual, location, region, and ethnic group, which will contribute to reduced morbidity and improved physical constitution, endurance, and intelligence among the Vietnamese people.

From 1993 to 2005, the Vietnamese government established a national target program to control iodine deficiency through widespread salt iodization. Iodized salt coverage increased to 95% of households, reducing the prevalence of goiter from 22% to 4% in children and increasing the average urinary iodine content from 32 μg/L to 130 μg/L in children aged 8 to 10 years [144]. Only 73.6% of respondents reported using iodized salt in any form in their households, while the target was 90% [135]. In recent years, Vietnam has achieved a significant reduction in child malnutrition thanks to positive effects of maternal and child health programs [145].

Clinically significant deficiencies are as follows: iron and zinc in children aged 6–8 months; iron only in children aged 9–11 months; vitamin B_2, calcium, iron, and folate in pregnant women; vitamins B_2, B_6, calcium, and folate in lactating women and adolescent girls; calcium and iron in non-pregnant women [146].

One measure to combat micronutrient deficiencies is to fortify foods with vitamins and micronutrients, for example, milk, vegetable oil, fish sauces, powdered flavorings, soy sauces, and wheat flour [137], infant formula and complementary foods [71], nutrient-dense complementary foods [147], rice[3], instant noodles [148], cookies [149], and locally produced peanut bars

[1] https://www.fao.org/faolex/results/details/en/c/LEX-FAOC142707/

[2] https://www.fao.org/faolex/results/details/en/c/LEX-FAOC213441/

[3] Nguyen T.T.L., 2024 Joseph M., Beesabathuni K., Matthias D. Enhancing the iron content of milled rice with path’s ultra-rice® technology. http://www.path.org/publications/files/TS_ur_enh_iron_pos.pdf.

[150]. Fish sauce was identified as the most suitable food product for iron enrichment, as it is consumed by more than 80% of the population [144, 151] and has been effective in controlling iron deficiency anemia [144]. In 2011, the Vietnam Food Administration developed and issued national technical regulations on food enrichment, which further contributed to the creation of favorable conditions for food enrichment [144]. To support fish sauce fortification, the Global Alliance for Improved Nutrition awarded a grant to the National Institute of Nutrition for 2006–2009. This program achieved the production of fortified fish sauce in ten factories, reaching more than 575,000 people. The effectiveness of fish sauce fortification in improving iron status among women of reproductive age in Vietnam has led to a reduction in the prevalence of iron deficiency from 22.3% to 4.0% and anemia from 24.7% to 8.5% [151]. The average consumption of fish sauce in villages was 13–18 ml/person per day [151]. At this level of consumption, fortifying it with 7 mmol of iron/L would increase the added value of the sauce by 8%, which would amount to US$0.11 per person per year [151].

In addition to fish sauce, vegetable oil, flavorings, and soy sauce are also target products for fortification, as they are consumed by 60–90% of the population [144]. Other measures include promoting breastfeeding, developing government-supported school feeding programs, and deworming to prevent iron deficiency [2, 71, 92, 106, 108].

Fortification of milk and biscuits with iron, zinc, iodine, and vitamin A, as well as increasing the calorie content of these products by an average of 300 kcal, contributed to accelerated growth and weight gain in children aged 1.5–2 years 5 months to 2 years after the start of consumption of fortified products [2, 149]. Enriching biscuits with several micronutrients is an effective strategy for improving the micronutrient status of Vietnamese schoolchildren and increases the effectiveness of deworming [148].

Adequate nutrition counseling programs that include information about the dangers of micronutrient deficiencies and social support, the creation of a flexible supplement intake scheme, and the involvement of community leaders in the promotion and marketing of dietary supplements and their free provision are positively perceived by the population [152].

Additional intake of dietary supplements containing micronutrients and vitamins is another way to correct deficiencies [2]. For example, prescribing supplements containing iron and folic acid before conception improved linear growth and fine motor skills in children aged 2 years [75]. Taking combined supplements containing zinc, iron, and vitamin A increased plasma retinol by 15% and reduced the prevalence of zinc deficiency by 17.3% [153]. The prescription of vitamin A capsules in 1988 reduced the prevalence of xerophthalmia [119]. Combined supplements containing zinc, iron, and folic acid, proteins, fats, and B vitamins, consumed by pregnant and lactating women, as well as children, in combination with dietary counseling, contributed to an increase in hemoglobin (decrease in the prevalence of anemia), ferritin, iron, zinc, plasma retinol, and urinary iodine in children and women [18, 60, 129, 138, 149]. Adding small amounts of locally produced fortified foods to the diets of Vietnamese women of reproductive age increased levels of iron, zinc, vitamin A, and vitamin B_{12} [154].

Recent national dietary recommendations for pregnant women suggest adding fatty acids from the 16th week of pregnancy [155] to prevent congenital anomalies [156, 157]. Vietnam's National Nutrition Strategy for 2011–2020 does not mention encouraging the addition of fatty acids, as a result of which Vietnamese women may not be aware of their importance [155]. Congenital malformations that can be prevented with nutrient supplements remain one of the three leading causes of neonatal mortality in Vietnam [158]. The prevalence of anencephaly was estimated at 3.6 per 10,000 live births in Vietnam in 2010, which is higher than the corresponding figures in the United States (1.9–2.3 per 10,000 live births in 1995–2011) and Thailand (0.8 per 10,000 live births in 2001–2012) [158].

Vietnam has programs that focus on developing agriculture and small-scale animal husbandry. Both are seen as promising and culturally important ways to improve food security for the population [120]. Raising awareness about fruit and vegetable growing in home gardens and community gardens could reduce the financial burden of purchasing essential foods [159]. Promoting livestock farming at the household level could improve the supply of animal-based foods, which are rich sources of iron, zinc, and vitamin B_{12}. For example, the production of chicken liver (a source of iron, zinc, and B vitamins), due to its affordability [146], will, according to some authors, help reduce malnutrition [146]. High consumption of dairy products has been associated with significantly higher concentrations of vitamin B_2, calcium, vitamins D and B_1, A, fat, protein, zinc, iodine, and bifidobacteria [160]. In order to implement agricultural development programs at the family level, the country has a Training and Implementation Center that promotes the improvement of veterinary services and animal breeding — Vuon Ao Chuong ("Garden Pond, Barnyard") [159].

CONCLUSION

To sum up, it should be noted that over a period of almost 30 years, the Vietnamese government, thanks to the adoption of the National Nutrition Strategy, has managed to reduce the number of school-age children suffering from stunted growth and underweight by approximately 2–3 times. Measures introduced to enrich foods with vitamins and micronutrients have also led to a reduction in the number of children and adults suffering from anemia, iron deficiency, and vitamin A deficiency. However, vitamin D deficiency remains a public health problem, which is linked to traditional Vietnamese beliefs about the physical attractiveness of people with white skin. The main factors contributing to malnutrition, stunting, and micronutrient and vitamin deficiencies are: anthropometric deficiencies caused by parental malnutrition, low levels of culture and education, inadequate breastfeeding, economic reasons for not eating enough meat and vegetables, especially among residents of poor rural and mountainous regions, food shortages, as well as parasitic diseases and intestinal infections.

ADDITIONAL INFORMATION

Authors' contribution. All authors made a substantial contribution to the conception of the study, acquisition, analysis, interpretation of data for the work, drafting and revising the article, final approval of the version to be published and agree to be accountable for all aspects of the study.

Competing interests. The authors declare that they have no competing interests.

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